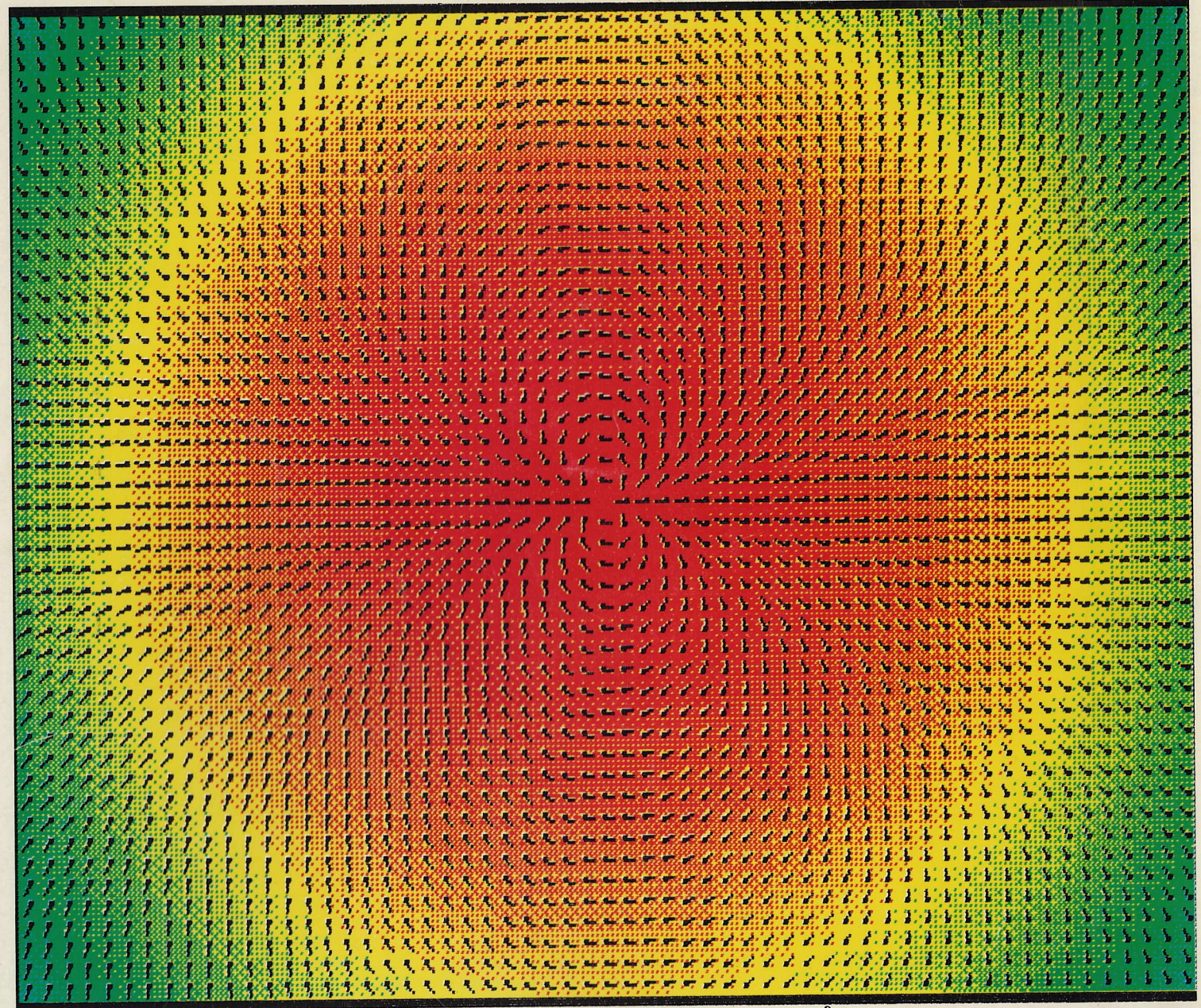


Beauties of Mathematics Calendar VII 1989

Produced at the
Charles and Jeanette Muench
Center for Color Graphics
Florida State University
E.P. Miles, Director
(904) 644-1587

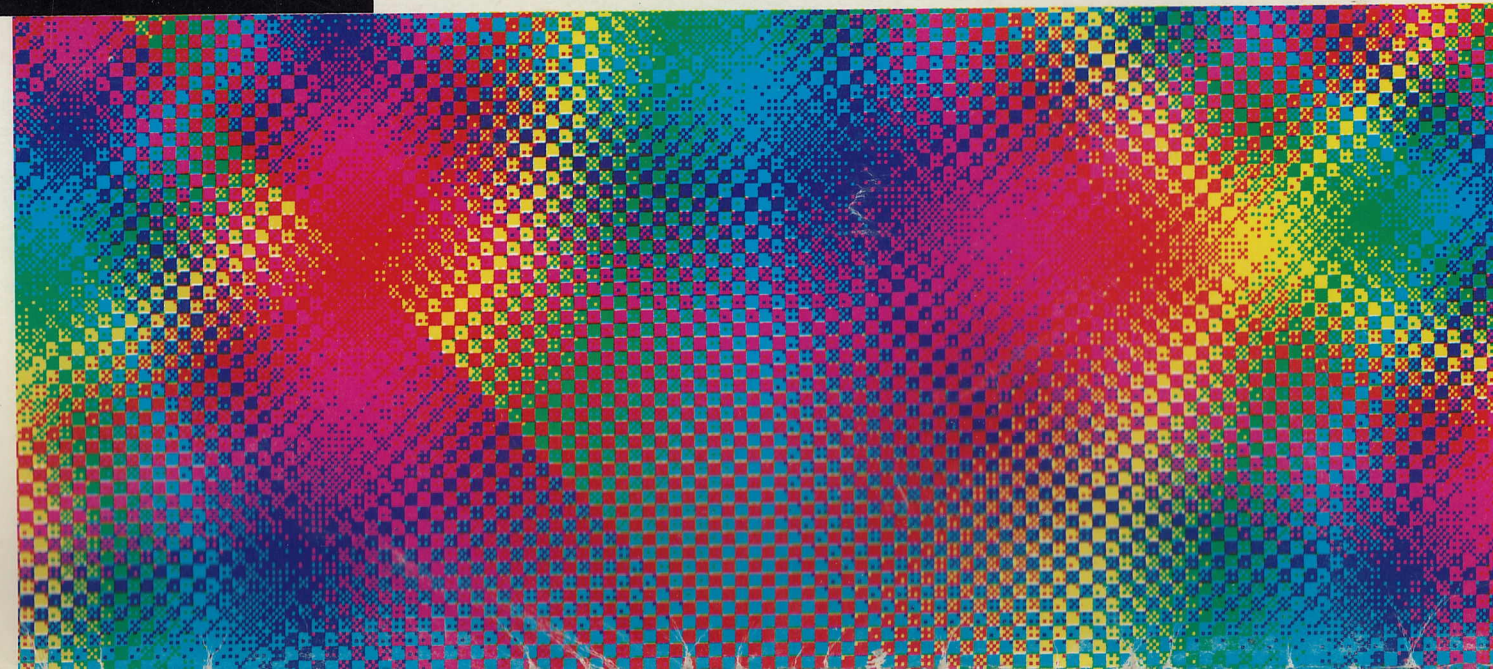


January, 1989 : Seminole Sunburst $f(Z) = \frac{Z^2}{36}$

January			
Sun	Mon	Tues	Wed
1	2	3	4
8	9	10	11
15	16	17	18
22	23	24	25
29	30	31	

February			
Sun	Mon	Tues	Wed
			1
5	6	7	8
12	13	14	15
19	20	21	22
26	27	28	

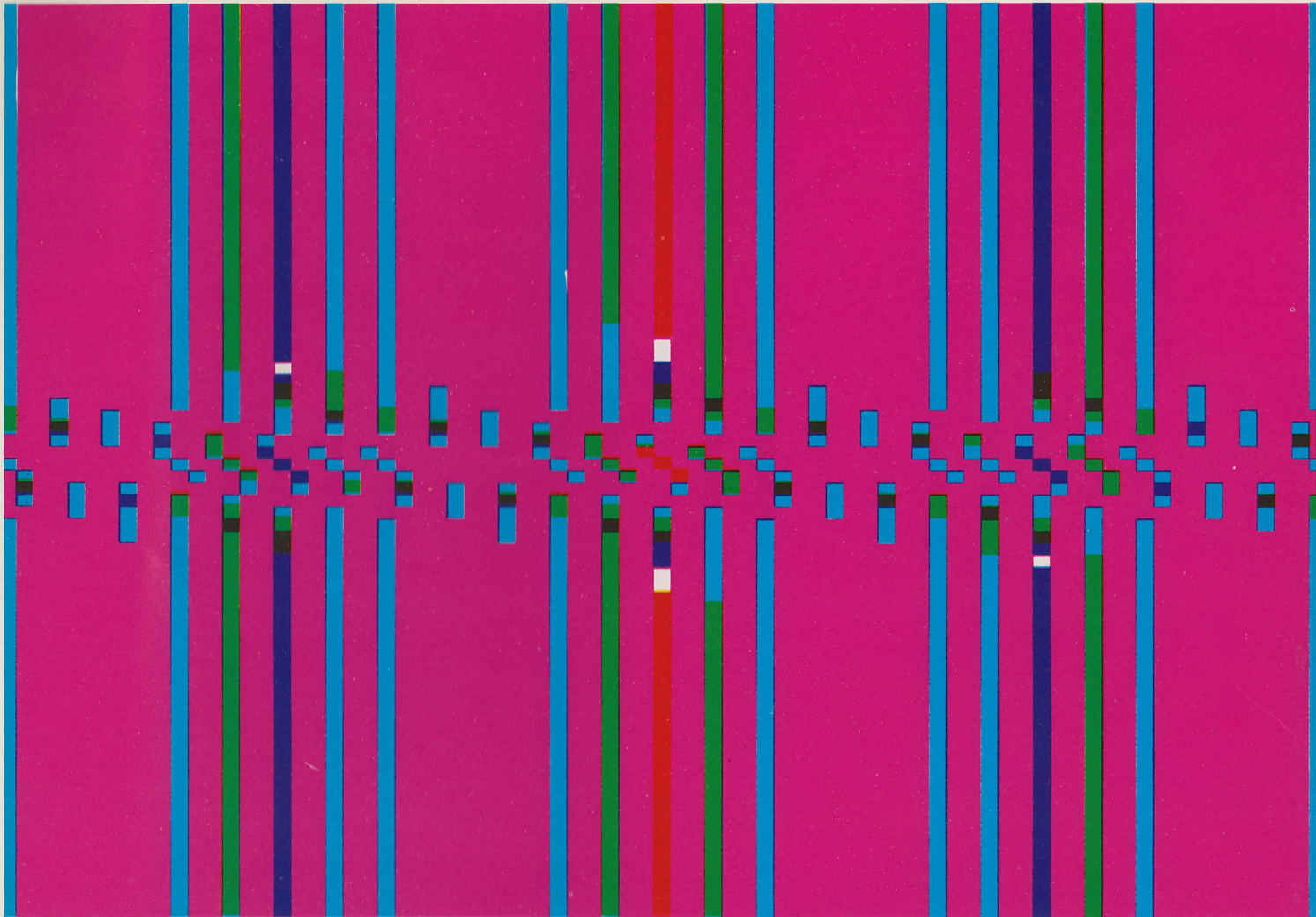
March 1989						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	



All color separations
DIGITAL FAST
(FAST ADDITION)
SEPARATION IN
MIL

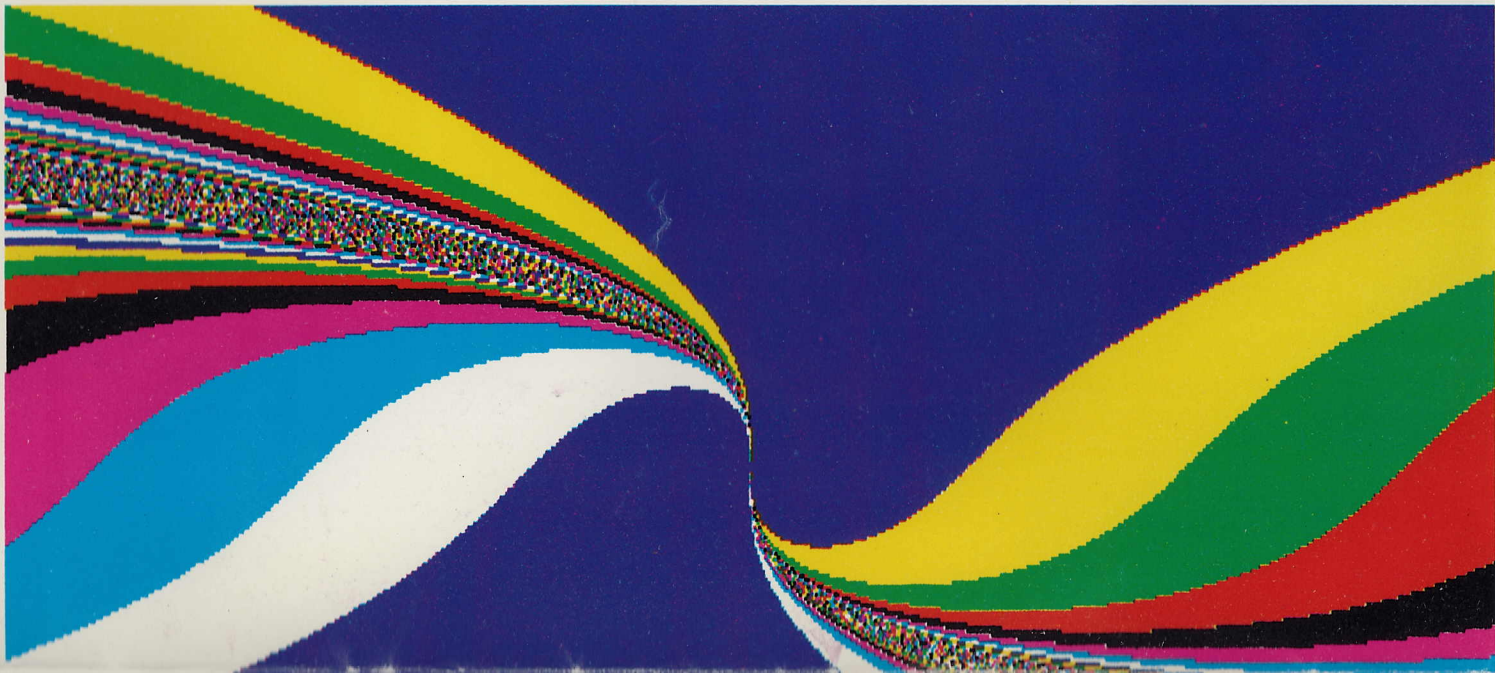
y 1989		
Thurs	Fri	Sat
5	6	7
12	13	14
19	20	21
26	27	28

y 1989		
Thurs	Fri	Sat
2	3	4
9	10	11
16	17	18
23	24	25



February, 1989 : Shattered Stripes $f(x,y) = \ln(7 \cdot \text{abs}(\sin(x + y \cdot \exp(1 - \text{abs}(y)))) + 0.01)$

tions used the
CSIMILES
TIVE COLOR
TERNEGATIVES
ES)



Color Block Graphs Without Computers

Journal of the Alabama Academy of Sciences, 1955

Miles work in low-resolution color graphics dates back to 1955, when he had no involvement with computers. Yet the keystone of his work in computer-generated color block graphs for the past twelve years has been the algorithm described in the abstract from the 1955 Annual Meeting of the Alabama Academy of Science, quoted in full:

Colorful Mathematics or Functional Design

Let us consider any plane area divided into a grid of equal squares by two perpendicular families of parallel lines. We associate with some centrally located square the coordinates (0,0). The square a squares to the right of the origin and b squares above it is given coordinates (a,b). Squares to the left of the origin have a negative first coordinate; those below the origin have a negative second coordinate. Suppose we wish to create a block design using a certain number of colors or individual block designs; say, for instance, a five-color design. We associate with each of the numbers 0, 1, 2, 3; and 4 a different color. By using various integer-valued functions $f(x,y)$ reduced modulo 5, we associate one of these numbers and its color with each square in the grid. In case the function used is a polynomial in x and y , this produces a design formed by repetition of basic 5 by 5 groups of 25 squares. By taking $[f(x,y)]$, the greatest integer in $f(x,y)$, patterns can be formed for functions of integers which may take on non-integral values.

Using $[f(x,y)]$ modulo n , we may also form color patterns in ordinary rectangular Cartesian coordinates. In this instance the color at any point (x,y) on the design would be that corresponding to the greatest integer not exceeding the value of $f(x,y)$ reduced modulo n . This technique may be used with polar coordinates also. A tablecloth sold at the International Congress of Mathematics 1954 uses the distribution of Gaussian primes to develop a two-color block design.

April 1989						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

H
A
P
P
Y

We appreciate the printers efforts in producing the Beauties VII Calendar for 1989. This calendar was printed using only four colors - black, yellow, cyan, and magenta on a two color press. The color separations were provided and reduced the overall printing cost of this calendar by 30%.

BEAUTIES OF MATHEMATICS CALENDAR VII
1989

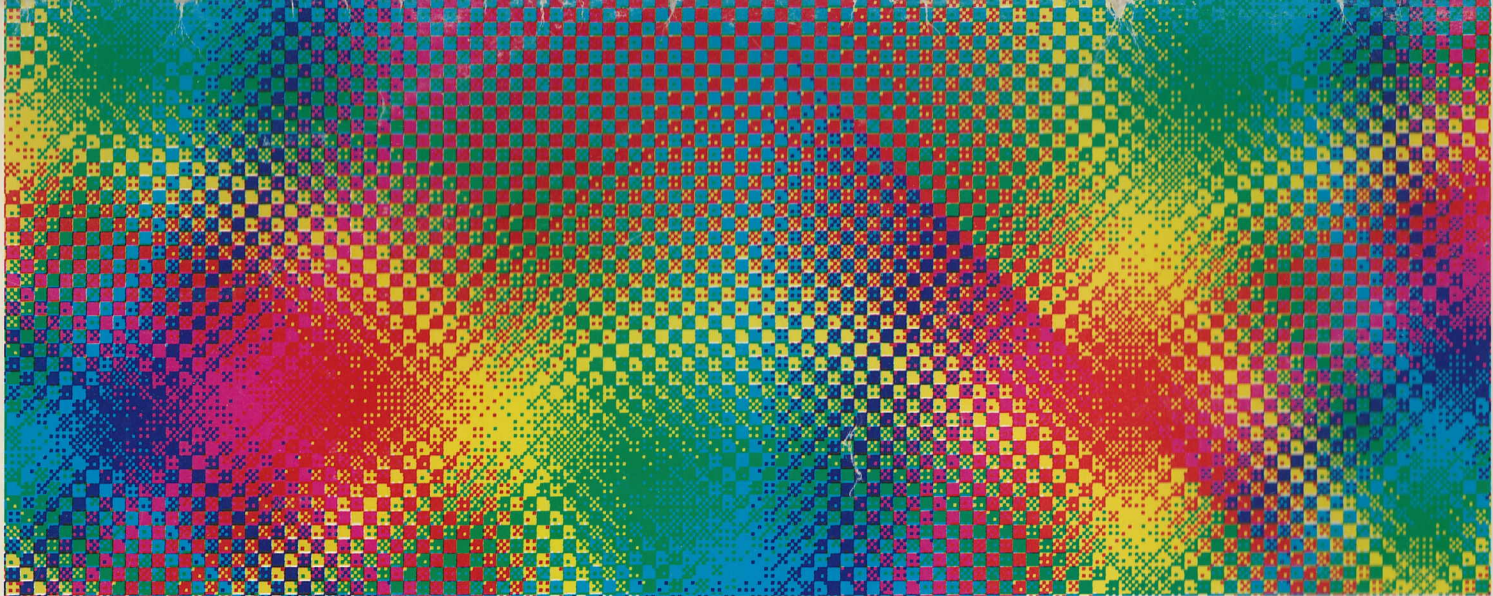
The production of this seventh non-profit Beauties of Mathematics calendar by Dr. E. P. Miles, Jr. and his student assistants has been made possible by the continuing generosity of Charles and Jeanette Muench of Norcross, GA, and the various color graphics companies with which they have been associated. Their 1984 donations of forty Intecolor 2427 workstations supported by Datavue 3000 controllers, Printacolor ink jet printers, and Siemens black and white printers added to our five previously donated Intecolor 8000 series work stations made it possible for us to support computer programming and art courses with enrollments up to thirty. 1985 donations of two Intecolor VHR-19 terminals enable us to continue state of the art research.

All seven calendars have been created as a non-profit educational project of Miles Color Art in cooperation with The Florida State University and participating vendors. Artwork, production time, and use of the patented separation process have been donated. Sales of calendars donated or sold at overrun cost have benefited many organizations. For this calendar distributions are planned for the meetings of the American Mathematical Society, the Mathematical Association of America, the AAAS Mathematics Section, the Florida Instructional Computer conference in January, the ACM Computer Science Education conference in February, the National Council of Teachers of Mathematics conference in April. As usual copies will be distributed to students excelling in pre-college competition in math, science, and overall academic competitions. In the past, these have included students ranking high in science fair, brain brawl, math counts, etc. and to students selected for gifted programs in school year or summer sessions. The Florida State Department of Education arranges for copies to go to each school principal for display in the media center - library and sends one copy to each county supervisor for mathematics and computer science.

Key gifted students helping to develop our image files and artist support programs in improving color palette environments since 1977 are: Phillip Jensen, Scott Rimbey, Laura Rimbey, William Jasiniecki, Eric Chamberlain, Raymond Curci, Doug Martin, Mark Schendel, Michael Sumner, Tracy Hamilton, and Donald Pace. The "Beauties" calendars show our progress in creating color graphics and their separations using U.S. Patent 4,430,668, a Digital FAC-SIMILES (Fast Additive Color Separations Inter-negatives MILES) process which makes thirty percent savings in printing costs possible. Since Calendar III, separation images have been printed on a color printer attached to the generating computer.

We now create and separate designs in the 8, 27, 125, 729, and 4913 color palettes explicitly described in our 1981 patent application, and in other self dual palettes such as the 96 pure colors of the superpixel color wheel. Camera ready copy of the text portion of Calendar IV was for the first time created using the word processing and symbol generated capacity of our various Intecolor terminals. We thus illustrated preparation at one station of all pre-press elements of books, manuals, brochures, reports, etc. i.e. text, color graphs, art work, and color separations. In 1985 a laser printer added better quality print and in this calendar our displayed formulae are greatly improved using Don Knuth's TeX, and troff. For this calendar we are also demonstrating some of the capabilities of the Ventura Publisher package with the cooperation of Howard Huff, President of SoftKlone, marketers of the Mirror family of communications software.

We have provided an annotated bibliography which should allow motivated readers to learn more of our methods. Also, for the six graphs on each side of the poster, we are including a tricks of the trade discussion as applied to the functions involved.



March, 1989 : Hyperbolic Cross Currents, Color Wheel Version $f(x,y) = (x+y)mod2 \cdot \frac{x^2-y^2}{256} + (x+y+1)mod2 \cdot (\frac{xy}{128} + 48)$



May, 1989 : High Resolution Tulip $f(x,y) = \frac{\frac{y}{4} \cdot abs(x) + abs(x)^{\frac{100}{abs(x)+abs(y)+0.5}}}{100}$

process, covered by U
related Canadian
Japanese and Europ

May			
Sun	Mon	Tues	W
	1	2	3
7	8	9	10
14	15	16	17
21	22	23	24
28	29	30	31

June			
Sun	Mon	Tues	W
4	5	6	7
11	12	13	14
18	19	20	21
25	26	27	28

U.S. Patent 4,430,668,
Patent 1,180,286,
can patents pending.



Major providers of equipment and support include:

INTELLIGENT SYSTEMS

INTECOLOR

DATAVUE

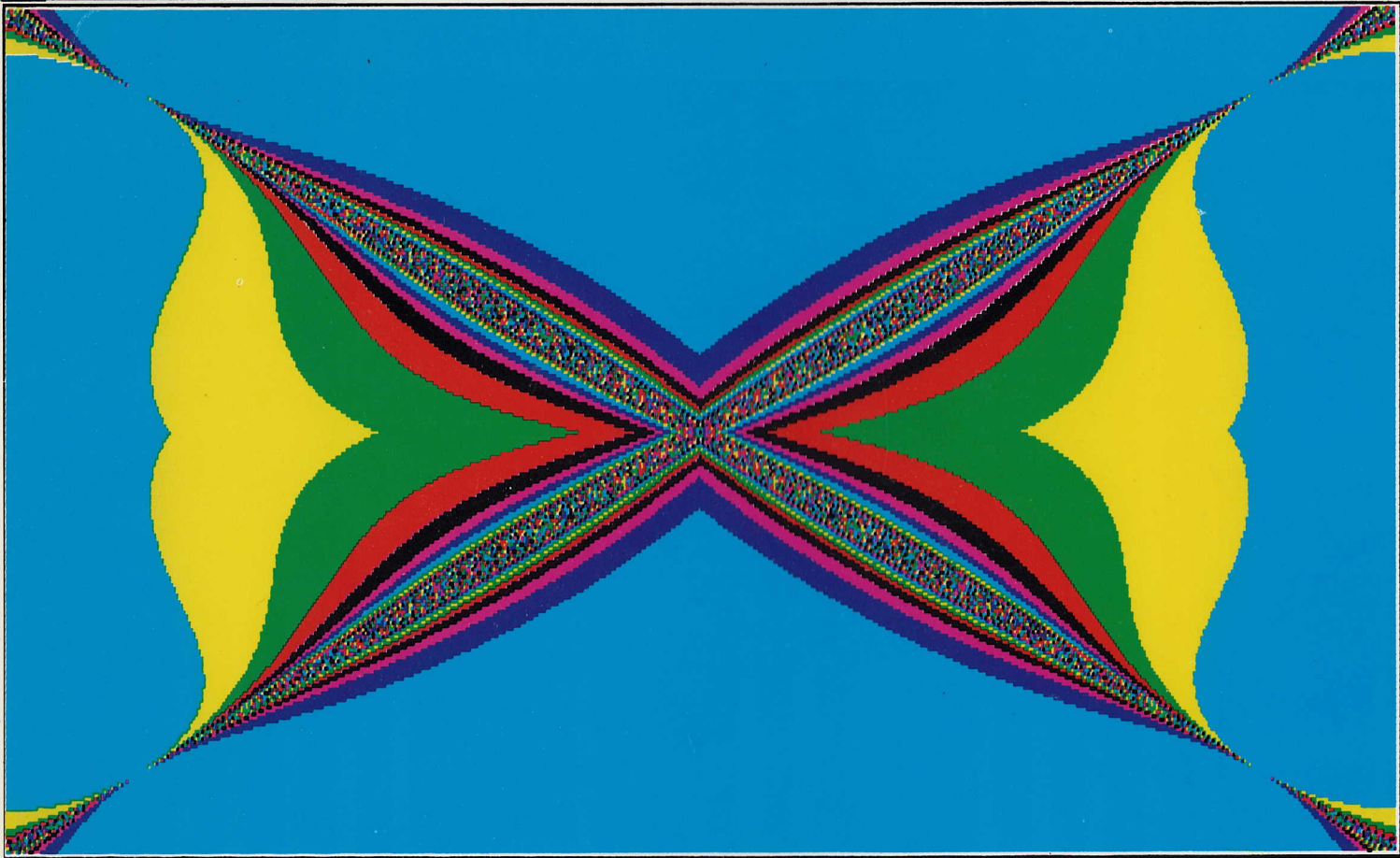
QUADRAM

1
9
8
9

April, 1989 : Birds Refueling in Air $f(x,y) = \frac{3 \cdot (3x - y)^2}{300 \cdot x + y^3 + 0.03}$

1989			
	Thurs	Fri	Sat
	4	5	6
	11	12	13
	18	19	20
	25	26	27

1989			
	Thurs	Fri	Sat
	1	2	3
	8	9	10
	15	16	17
	22	23	24
	29	30	



X-values are -38 to 38 Y-values are -38 to 38 Colors are 43210564
 $((3 \cdot \sin(\text{abs}(x/13)) + 3 \cdot \cos(y/13))^2 / (\text{abs}(x) - \text{abs}(y) + .03))$

Tricks of the Trade

January:
Our Seminole Sunset was one graphic designed to be exactly appropriate for the Florida State University athletes known as Seminoles wearing the school colors of garnet and gold. This graphic, which was the cover for Calendar II, illustrates a breakthrough in mathematics education. It is a 4 dimensional graph showing for each complex integer, the absolute value of $f(z) = (z^2)/36$ to the nearest integer by the color corresponding to the numbers modulo 96 on a color wheel of superpixels beginning with red = 0 and with interpolations between yellow at 16, green at 32, cyan at 48, blue at 64, magenta at 80 and back to red at 96=0. Since the absolute value of z^2 is $x^2 + y^2$, points at the same distance from the origin have the same color. Where do the short line segments come from ? The complex number in polar form has a direction as well as a magnitude. In the form $f(z) = u + i \cdot v$, the direction is $\arctangent(v/u)$. At each block representing $f(z)$, the program computed the slope and plotted in black over the pure color values a line segment to indicate that direction. We see here a good illustration of DeMoivre's theorem. Note, that for each block for which the angle from the origin is w , the line drawn in that block has direction $2w$.

February:
Shattered Stripes we now dedicate to grand-daughter Allison born 2/22/1988. This looks like a good design for nursery purposes. Welcome Allison.

March:
The birthday of the author is March 16th. For his all time favorite Hyperbolic Cross Currents color wheel version is named in part because so many of the student assistants contributed to its evolutionary development from the 4 color low resolution form in Calendar I to the 96 pure color form on the cover of calendar V. Again, the superpixels were a great help. What's the trick here ? For any complex function $f(z) = u(x,y) + iv(x,y)$, the families of real functions $u=c$, $v=k$ are sets of orthogonal trajectories. The function $(x+y) \bmod 2 * u + (x+y+1) \bmod 2 * v$ puts the data from one function on the black spaces of the checker board and the data from the other on the red. We are actually dealing with the function $(z^2)/256 + 48i$ so that at points near the origin, the u family will have values corresponding to red, and the v family corresponding to cyan.

April:
This graph illustrated two principles useful in seeing the properties of functions. For points on or near the line $y = 3x$, the numerator is 0 or near 0. The programmer had assigned blue to the values near 0. Many of our interesting graphs come from the denominators. Of course, if the denominators are 0, the function will be undefined. Our cubic denominator has no 0s at integral points, but it becomes quite close to having such 0s causing rapid changes in value as we straddle those points.

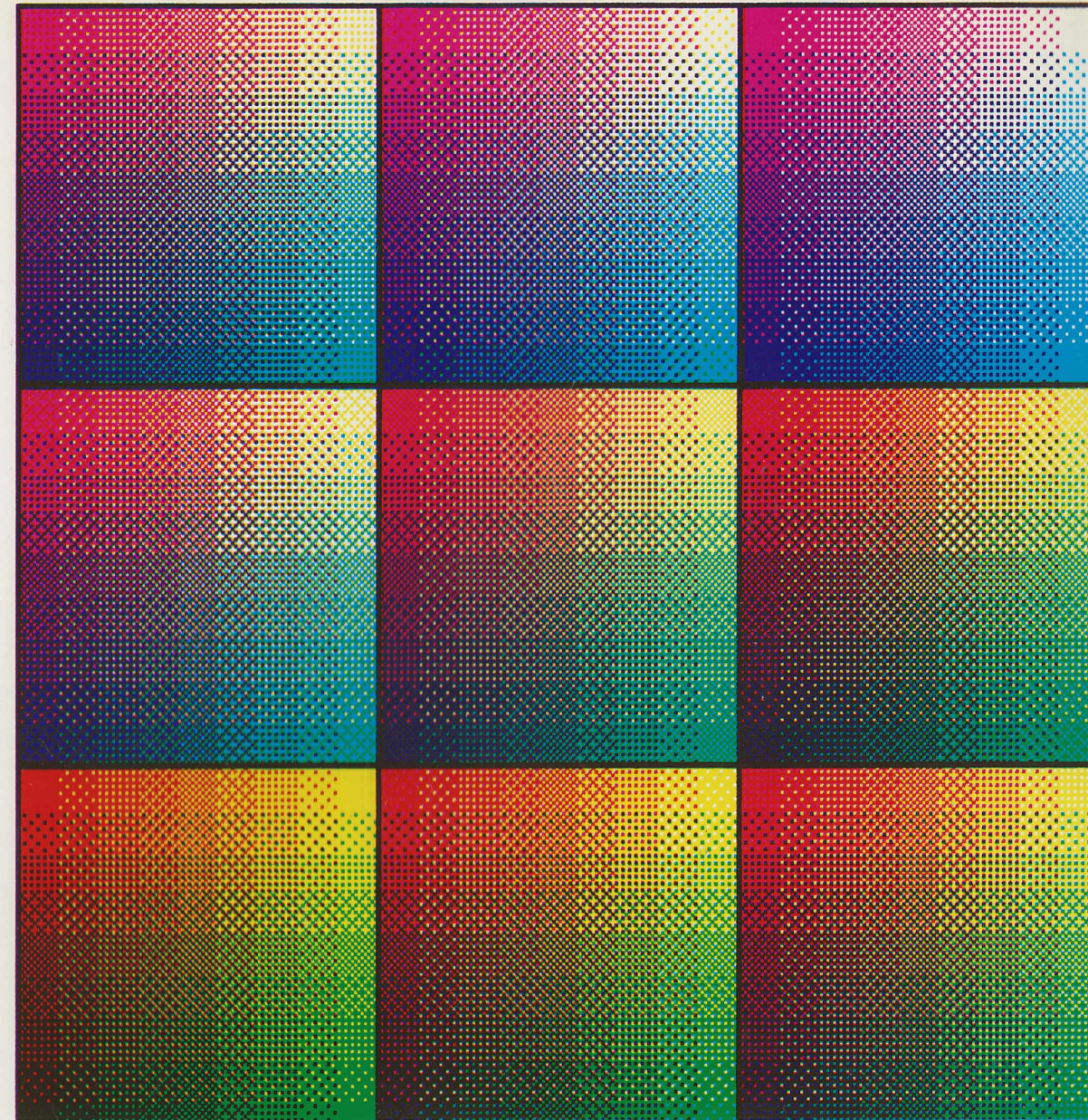
May:
High Resolution Tulip is a derivative of our first 1980 test of the patented method. Rose Printing Company took a 35mm sized set of separations to ride piggy-back on the trim portion of an artists limited edition print.

June:
We have had many spectacular versions of butterfly. One key point to observe is the near singularities on the lines $y = x$ and $y = -x$, caused by the denominator. You might want to examine the trigonometric numerator to see the influence it has on the graph.

June, 1989 : Better Butterfly $f(x,y) = \frac{(3 \cdot \sin(\text{abs}(x/13)) + 3 \cdot \cos(y/13))^2}{\text{abs}(x) - \text{abs}(y) + .03}$

Select Annotated Bibliography

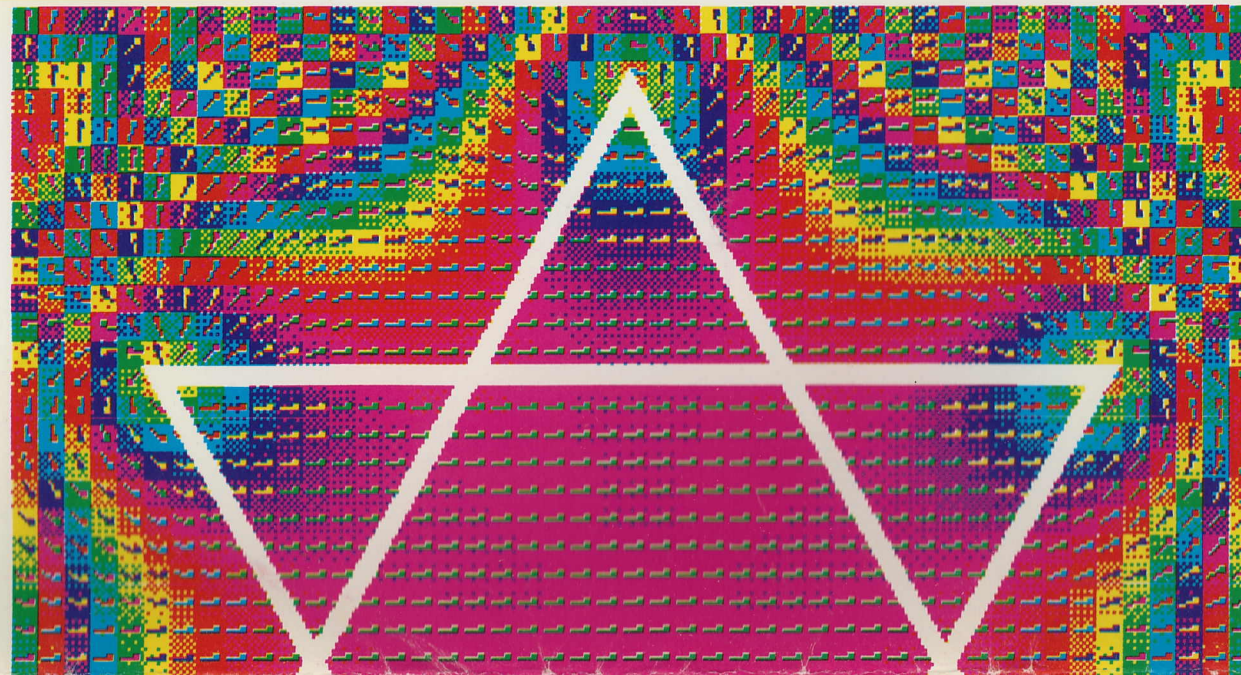
11. "Functional Design or Colorful Mathematics." (Abstract) *Journal of the Alabama Academy of Science*, 27 (1955).
37. "Computer Augmented Undergraduate Science Education." *Proceedings of the International Congress of Applied Learning Technology, February, 1978. (An invited address.)*
38. "Computer Generation of Color Block Graphs Generated by Mathematical Functions." *Proceedings of the Southeastern Regional Meeting, Association for Computing Machinery. April, 1978.*
41. "Computer Generated Color Art Forms Using Mathematical Functions." Abstract of invited presentation, AAAS, Art & Technology Symposium, Houston, Texas, January, 1979.
42. "Colorful Mathematics or Functional Design", *The American Math Monthly* Vol. 86, No. 5. Abstract from refereed poster session--MAA, Biloxi, Mississippi, January, 1979.
39. "Computer Related Modules for Mathematics Instruction." Abstract presented at the International Congress of Mathematicians in Helsinki, Finland. August, 1978.
43. "Color Graphics With Mathematical Applications." (Educational) Abstract of invited address for the National Educational Computer Conference '79, Iowa City, June, 1979.
44. "Color Graphics With Mathematical Applications." (Scientific) Abstract of invited address for SIGGRAPH '79, Chicago, August, 1979.
45. "Models for the Color Continuum and Subsets There of." ACMSE '80, *Proceedings*, (Five related color graphics appeared on the cover of these *Proceedings*.) Tallahassee, March, 1980. (First printed color graphics of author, traditional color separation used)
46. "The Beauties of Mathematics Revealed by Color Block Graphs." Abstract refereed for poster session. International Congress, Mathematics Education IV, Berkeley, CA, August, 1980. (Includes first four-dimensional graphs of vector function. (SIAM Education Editor said Miles' polaroid poster was the most significant exhibit of the Congress)
47. "Dual Pseudo-Algebras for Closed Color Systems." Abstract number 779-00-1 for the 84th summer meeting of the American Mathematical Society. Page 401 of *Abstracts*, August, 1980.
48. "Creative Art and Custom Interior Design in the 80's." ACM '80, *Proceedings*, pages 453-456 (Three relevant color graphics appear on the cover of this *Proceedings*.), Nashville, Tennessee, October, 1980.
49. "Self Dual Harmonic Models for the Creation of Additive and Subtractive Color Patterns." Abstract no. 783-05-32, for the 87th annual meeting of the American Mathematical Society, page 14, *Abstracts*, Jan. 1981.



July, 1989 : Homage to a Square, Austin 729
729 color cubic set for the digital FACSIMiles separation process

September 1989

Sun	Mon	Tues	Wed	Thurs	Fri	Sat
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30



July			
Sun	Mon	Tues	We
2	3	4	5
9	10	11	12
16	17	18	19
23	24	25	26
30	31		

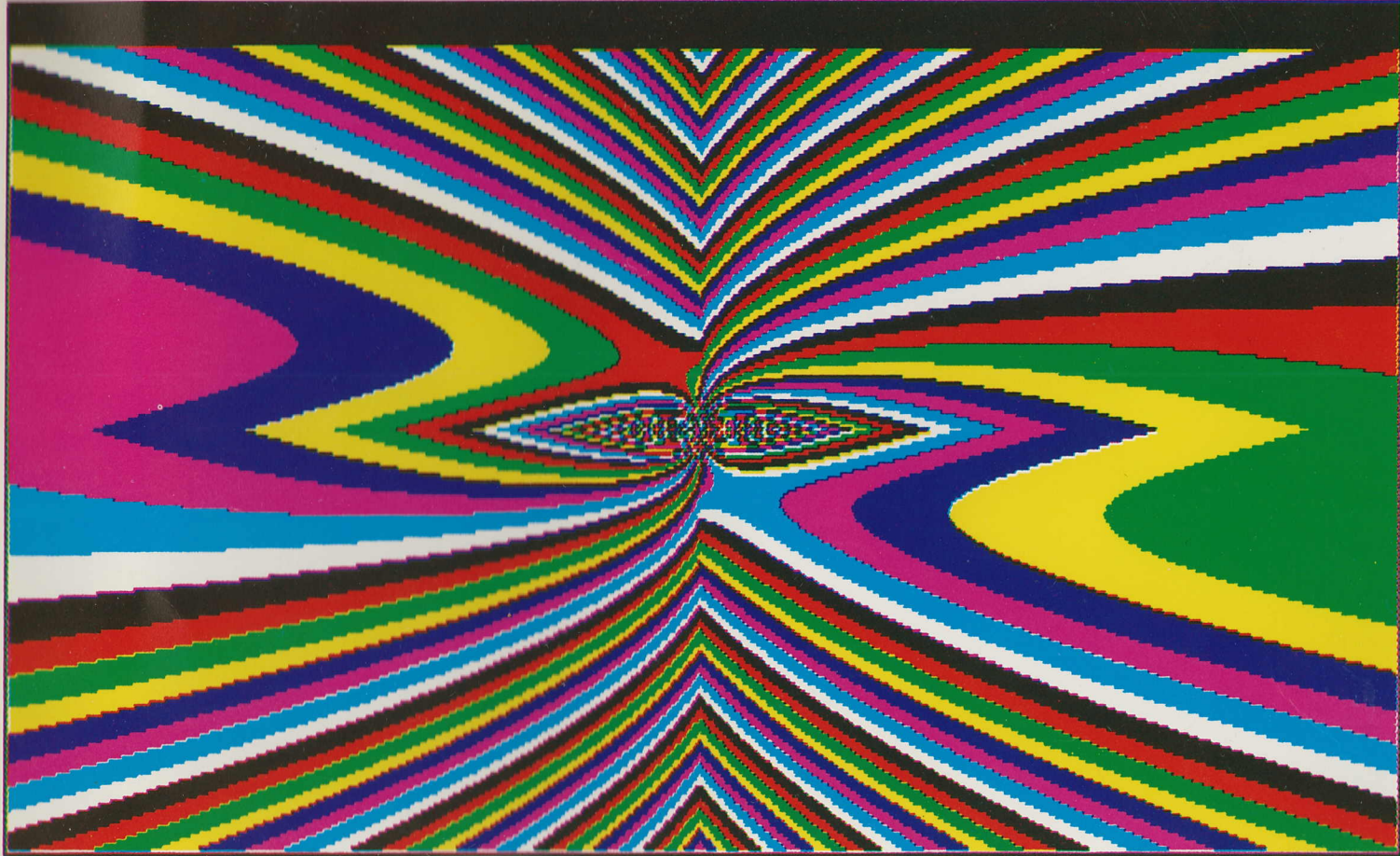
August			
Sun	Mon	Tues	We
		1	2
6	7	8	9
13	14	15	16
20	21	22	23
27	28	29	30

previously published low resolution color

62. Color graphic cover for vol. 75, no. 9, 1989. *Nudo and Douglas Martin. Note also the "Color that Counts: E. P. Miles and Math FSU R & R, also the first use of Digital superpixel graphics with separation images controlled by the Intecolor 8064-R desktop*
63. "Computer Color: Paint by Number", *Sch* 1983, pp. 6-7, pp. 75-76, front cover.
64. "Beauties of Mathematics III", a sixteen December 1984. (All separations for print were printed by the Intecolor 8064R PC. Each registrant at ACM 83 N.Y. received work station used for its creation in a don three day period.
65. United States patent no. 4,430,668; February Color Separation Internegatives -- MI
66. The LeMoyne Eleven Limited Edition A tor of the LeMoyne Art Gallery in Tallah leix, spent nine hours selecting about 70

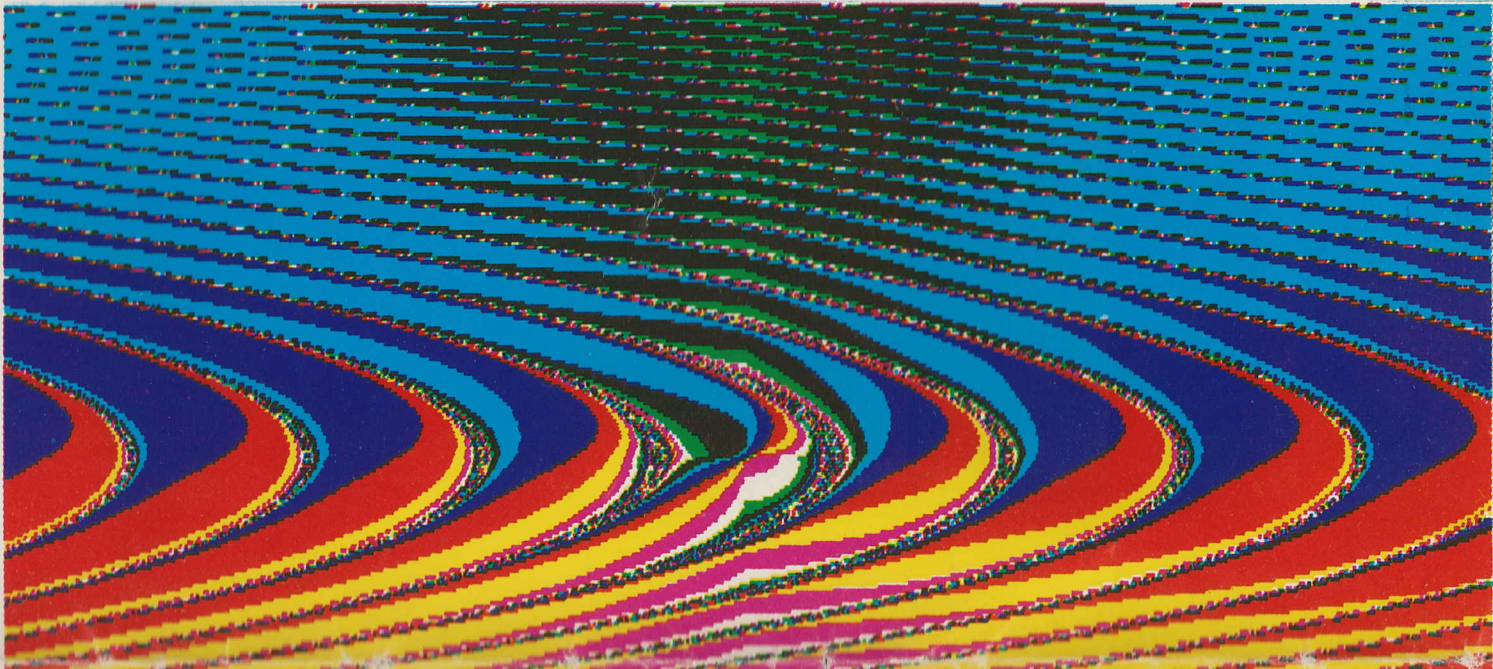
1989			
Thurs	Fri	Sat	
		1	
6	7	8	
13	14	15	
20	21	22	
27	28	29	

1989			
Thurs	Fri	Sat	
3	4	5	
10	11	12	
17	18	19	
24	25	26	
31			



August, 1989 : Variegated Vortices Revisited

$$f(x,y) = \frac{100 \cdot x - y^3}{(abs(x) + abs(y))^2 + 0.3} = -f(-x,-y)$$



50. "NSF" Support for Mathematics Education." An invited chapter for *Mathematics Tomorrow*, pages 139-152, Springer-Verlag, 1981.
51. "Color Graphics in Education, Art and Industry." An abstract of an invited ninety minute lecture demonstration. *Proceedings of ACM Conference, Los Angeles, November 1981.*
52. "Digital FACSIMILES "(Fast Additive Color Separation Internegatives--MILES)." US Patent application filed August, 1981. (Japanese, Canadian, and European applications filed in August 1982), cf Ref 47+ 49
53. "Beauties of Mathematics, a Planning Calendar for 1982." Twelve color graphics appear as beauties of the month. The first published graphics using ref. 52 methods , i.e. slides of computer screen black and white separation images. A 90 minute invited demonstration lecture (reference 51) about the new techniques used in producing in this non profit calendar was given at ACM 81, Los Angeles.
54. Cover and inside credit for Florida State University Film Catalog, 1982 (The graphic "Fire and Ice" used the same color separation method by photography of black and white inter-negative images as was the case in the color graphics referred to in 53.) The subtitle, Films, in designer's letters used alternate technology in the FACSIMILES patent process for producing the color separation images on an IBM laser printer. (Widely distributed around Florida, USA, etc.)
55. "Creative Art and Custom Interior Design in the 80's", *Journal for Interior Design, Education and Research*, Spring, 1982 pp. 32-34. Article 48 above reprinted by permission of ACM.
56. "Creative Art and Custom Interior Design in the 80's", an update for 1980-1982. *Ibid*, pp. 35-36.
57. Use of color graphics to display scientific data. "Displays on Display" section of *Computer Graphics and Application*, NCGA/IEEE. May 1982. This paper includes five color graphics printed using traditional separations.
58. "Some Highlights of Low Resolution Graphics", *Ibid*. Contains four color graphics and refers to a fifth graphic on the Journal's cover. The issue of *Computer Graphics and Applications* containing articles 57 an 58 has for its cover design the graphic "Blue Lady Dancing", with color separations provided by the Digital FACSIMILES process. Compare 57.
59. Color graphics for "Creative Art and Custom Interior Design", (Items 55 and 56 above.) Centerfold insert for *JIDER*, vol. 8, no. 2, December 1983. The seven color graphics used were the first full color graphics published in this eight year old journal.
60. "Beauties of Mathematics II" December 1982, a planning calendar for 1983. Twelve additional mathematical beauties of the month. Vector functions and color wheel super pixel graphs were new concepts illustrated.
61. "A Potpourri of Color Graphics", *Proceedings*, ICCGC, March 1983, pp. 234-242 (The Miles graphic "Birds Refueling in Air" was the official logo for this conference, appearing on *Proceedings* cover, three preliminary announcements, and conference stationery. The inside cover for the *Proceedings* contained high resolution condensations of twelve

aphics of the author.)

FSU Bulletin *Research in Review*, with Randy ide about the cover on page 11 and the article p.10 . (This was the first color graphics used by FACSIMILES methods on high resolution-printed in-house on a PrintaColor GP1024 unit color computer, which produced the graph.

astic Math Magazine, vol. 3, no. 14, May 20,

month planning calendar, September 1983 - ng the sixteen color graphics for this calendar 24 work station first tested for no. 62 above.) copy of this calendar and Miles exhibited the ed booth at the conference for 20 hours over a

ry 7, 1984; Digital FACSIMILES (Fast Addi-ES)

Prints March 1984 (Dr. Ron Yrabedra, Direc-see, and of the Florida A & M University Gal-our computer display sta- is to be featured in

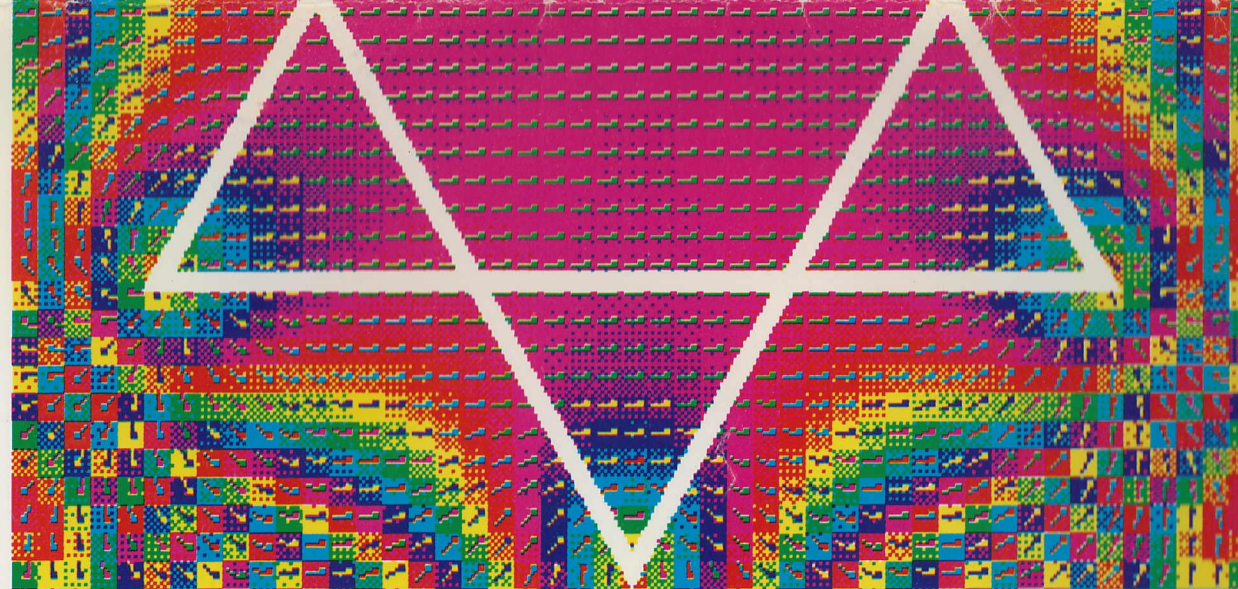
October 1989						
Sun	Mon	Tues	Wed	Thurs	Fri	Sat
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

- 1) Our major benefactor, Charles A. Muench, whose COLOROCS corporation in cooperation with Sharp & Savin are introducing "full color" copying and "full color" electronic printing world wide in 1989.
- 2) Our alumni friend, Howard Huff, President of SoftKlone corporation, producer of the highly successful MIRROR communication software packages and sponsor for our Ventura use in this Calendar.
- 3) Dr. Eugene Nichols, Distinguished Professor of Mathematics Education at F.S.U. and prolific author of texts who has used more of our color graphics than anyone else and distributed our calendar widely each year.
- 4) Ralph Turlington, long time State Commissioner of Education, now an official with A.C.T.

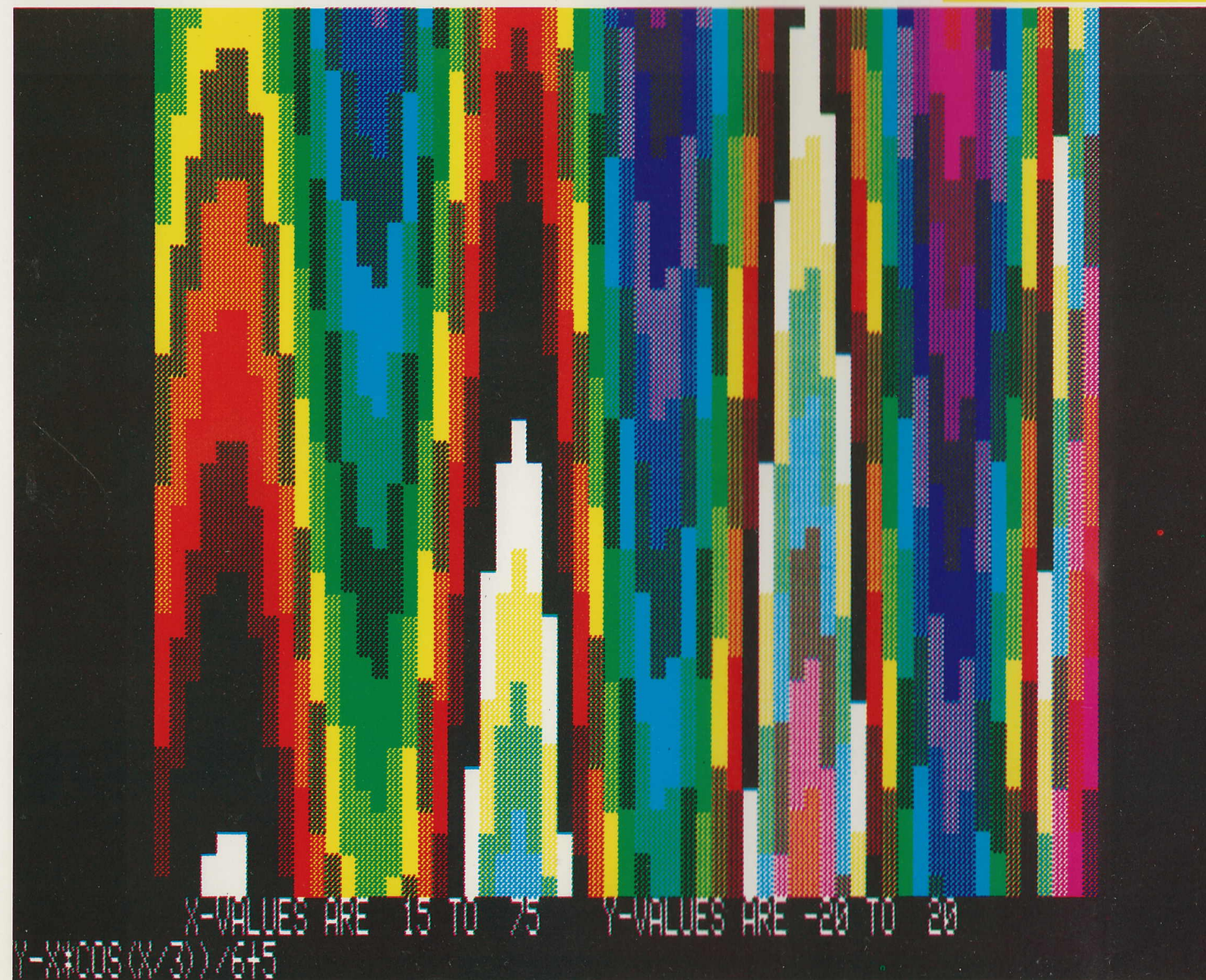
July 1989 Homage to the Square - Austin 729

The 729 colors expressed as base 9 integers have form: bgr where the blue level is $b/8$, the green level $g/8$ and the red level $r/8$. Thus a generic color point (pixel on super pixel) on our computer screen can be identified with a vector from the black origin extending $b/8$ units toward a fully activated blue pixel, $g/8$ toward green and $r/8$ toward red. Associated with this family of vectors used for describing the pixel screen lighting at each position on a computer display is a subtractive family ymc where $y = 8 - b$, $m = 8 - g$, and $c = 8 - r$. The simplest form of our patented digital separation process for three color process printing decodes the bgr components producing the additive display on the black screen to determine at each position the strength of cyan, magenta and yellow needed to print the corresponding image subtractively on white paper. The three control plate images are then printed as

subtractively on white paper. The three control plate images are then printed as



September, 1989 : Magenta Magen David
 $f(Z) = AZ^6 - B$ with the Star of David added using our art system



November, 1989 : Gold in Them There Hills $f(x,y) = \frac{y - x \cdot \cos(\frac{x}{3})}{6} + 5$

67. Beauties of Mathematics IV Color Graphs were done on computer workstations using Quadram, Printacolor, IBM PC equipment. This calendar was distributed to each booth and was used to display the LeMoynes approximately 100 more of our color graphs.

68. Canadian Patent #1,180,286 Digital FAC negatives *MILES*) effective 17 years from

69. Computers and Art at F.S.U. This was a prepared and distributed nationally to ne July-December 1985 period under a proj Science Foundation. This was one of fou the "How About" series of science ne

<i>November</i>			
Sun	Mon	Tues	We
			1
5	6	7	8
12	13	14	15
19	20	21	22
26	27	28	29

<i>December</i>			
Sun	Mon	Tues	We
3	4	5	6
10	11	12	13
17	18	19	20
24	25	26	27
31			

computer display graphs to be featured in
ks in March, 1984. Sixty of these were to be
intouts from our Printa- Color 1024s with fore-
ere to be 200 percent enlargements printed by
IMILES Separations. Our printing bill was 40
or slides or prints had been used to produce the
on. To put it another way, printing costs for
cent more had our separation process not been
chosen for the show was Fire and Ice Revisited
from the same separations used to print it in
ics Calendar III.)

ics Calendar for 1985. All pre- press activities
g our processes applied to Intecolor, Datavue,
t, and our Tektronix artist support program.
strant at ACM 84 San Francisco. A donated
even Limited Edition prints (reference 66) and
ics printouts.

IMILES (Fast Additive Color Separation Inter-
issue date of January 2, 1985.

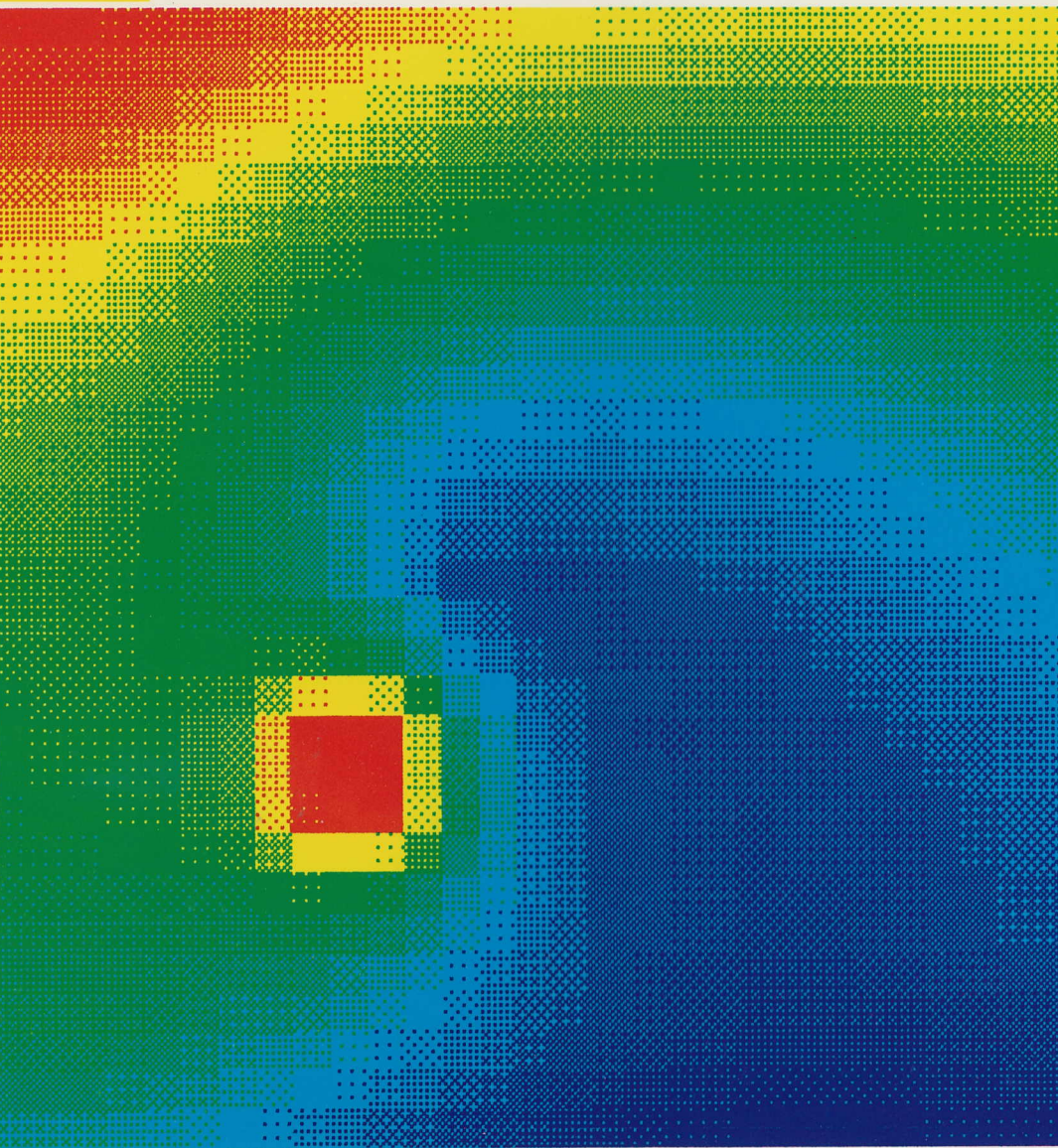
0 second public service video tape news release
ly 200 major television studios for use in the
t funded by General Motors and the National
F.S.U. projects selected for the 1985 releases in
s produced at Mr. Wizard Studios with Don

October 1989

Thurs	Fri	Sat
2	3	4
9	10	11
16	17	18
23	24	25
30		

November 1989

Thurs	Fri	Sat
	1	2
7	8	9
14	15	16
21	22	23
28	29	30



December, 1989 : Coordinated Colors Cool to Calorific
Colors assigned to 225 temperature points, colors between assigned by interpolation

October, 1989 : Fire and Ice Revisited
$$f(x,y) = 3 \cdot \frac{y - 3 \cdot \tan(\frac{x}{3} + \frac{y^2}{30})}{abs(x) + abs(y) + 0.3}$$

Herbert as M.C. Video sources from which this was edited were chosen from recent foot-
age of the F.S.U. Media News Bureau and local television covering of our activities dat-
ing back to 1978.

70. Beauties of Mathematics V Color Graphics Calendar for 1986. All pre- press activities
were done on computer workstations using our processes applied to Intecolor, Datavue,
Quadram, Printacolor, Sun Microsystems, Digital Equipment Corporation equipment, and
our locally developed GINED artist support program. This calendar was distributed to all
registrants at ACM 1985 in Denver Colorado and to the first 1000 registrants at ACM-
SIGCSE 1986. Local distribution was made to the winners in various competitions such
as science fairs, brain brawls, math counts, etc. Since industrial support for printing and
distribution costs dropped to about 55 percent as compared to 95 to 100 percent in previ-
ous years, it was necessary to raise more than \$5000 from local sources who appreciated
our purposes and had enjoyed free or marginal cost prices for calendars they had distri-
buted for non-profit educational purposes in previous years. (Many people were disap-
pointed that the proposed Calendar VI for 1987 did not appear. It was to have been distri-
buted at the ACM/IEEE Fall Joint Meeting in Dallas in November and was ready for the
printer in time for the deadline, but our prospective funders, Intelligent Systems and CBS
Books who seemed very positive in August 1986, dropped out completely as both firms
were put up for sale before the end of the year.

71. Beauties of Mathematics VI Color Graphics Calendar for 1988

Tricks of the Trade cont.

positives for process color printing using cyan, magenta, and yellow presses only. If
black plays a major role in a design, we modify this separation to print black directly
and avoid the poor quality black resulting from full strength overlays of cyan,
magenta and yellow.

For August 1989 we have repeated Variegated Vortices Revisited from June
1985. The function graphed has the symmetry property $F(X,Y) = -F(-X,-Y)$. By
evaluating the function modulo eight and assigning colors in the default manner:
black = 0, red = 1, green = 2, yellow = 3, blue = 4, magenta = 5, cyan = 6, and
white = 7, we see that any area in which the function takes on a certain integer color
value is matched by an equivalent area symmetric across the origin where the color
value displayed is the complement. This graph also illustrates rather pointedly the
continuity of the absolute value function for $X = 0$ and the discontinuity of its
derivative.

Our September 1989 entry was chosen to be the Magenta Magen David from
April 1985. The basic graph without the white overlays was that of the complex
function $AZ * * 6 - B$ scaled so the six symmetric zeros are appropriately placed. The
shield of David was superimposed using our artist's support system to draw its
boundaries and fill them with white.

October 1989 features the high resolution version of our first calendar cover,
1982, as it appeared in August 1984, calendar 3. This was also the first of Miles' Art
Prints. The periodicity of the tangent function accounts for the waves of near parallel
parabolas. The rapid changes of colors occur as the parabolic argument comes near
odd multiples of $\pi/2$, but never reaches them.

Our November 1989 entry is assigned to "Gold in Them Thar Hills" which was
chosen for the cover of calendar 3 by Vicki Miles whose birthday falls in November. A
modification of the graph boundaries enabled us to display her monogram AVM in the
left half of the picture.

Our last calendar 7 entry for December: Coordinated Colors - Cool to Calorific
appeared in calendar 3 for April 1984. We first created this graph for an article in the
May 1982 issue of Computer Graphics and Application. An article in the same journal
the previous year, July 81, showed 8 black and white ways of displaying the same 225
temperature values lying in a range from 2.3° C to 17° C. This graph in our response
paper expanded the 15 X 15 grid blocks to 29 X 29 and selected pure colors from our
96 hue color wheel. By assigning the coldest color 2.3 from the data, the color blue
and moving towards red for the warmest point in the distribution, one can follow the
temperature distributions as is commonplace now for the color weather maps of
television or USA Today etc. The colors assigned to the intermediate points in our 29
X 29 grid were chosen to be the color assigned to the number obtained by averaging
the numbers of the adjacent colored positions. This produced a smoothing of the data
pleasant to behold.